BIOLOGICAL EVALUATION OF GYPSY MOTH

at

James J. Rowley Training Center,
Goddard Space Flight Center,
National Plant Materials Center
and
National Plant Germplasm and Biotechnology Laboratory

Prepared by

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ABSTRACT

In the Fall of 2002, USDA Forest Service personnel conducted gypsy moth egg mass surveys at Goddard Space Flight Center (GSFC), James J. Rowley Training Center (JJRTC), the National Plant Materials Center (NPMC) and the National Plant Germplasm and Biotechnology Laboratory (NPGBL). All four of the small facilities are located near the Baltimore-Washington Parkway (MD Rt. 295) and the town of Greenbelt, Maryland. The purpose of these surveys were to assess the potential for defoliation and the need for treatment in 2003. Current populations are sufficient to cause noticeable defoliation on a total of 266 acres (GSFC – 42 acres, JJRTC – 92 acres, NPMC – 72 acres, and NPGBL – 60 acres). Treatment is recommended at each site to prevent defoliation and possible tree mortality.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a $1/40^{th}$ acre fixed radius plot was established. The plots consisted of a tally of all new (2002) egg masses observed on overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. The average egg mass length (measured in millimeters) and egg mass density (egg masses per acre) were used to estimate defoliation potential (Liebhold et al., 1993).

RESULTS

The location of the survey plots are shown in Figure 1. The summarized results of the surveys are presented in Tables 1-4. In brief, egg mass densities and egg mass lengths are fairly similar at all four sites. A comparison of the results is presented below.

Location	EM/acre range	EM/acre average	EM size range (mm)	EM size average(mm)
JJRTC	0-1,760	511	12-42	29
NPGBL	520-1,040	780	18-30	25
NPMC	160-600	360	28-42	35
GSFC	0-1,400	260	22-38	31

DISCUSSION

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (1-30 percent); moderate (31-60 percent); and heavy (61-100 percent).

The result of the surveys indicate that light to moderate defoliation is likely to occur in four areas encompassing 266 acres at these four sites in 2003 (Figure 2). This total includes 92 acres at JJRTC, 60 acres at NPGBL, 72 acres at the NPMC and 42 acres at GSFC.

This defoliation prediction is further supported when egg density is also used as a means of estimating gypsy moth population densities. Moore and Jones (1987) found that estimating the mean fecundity would increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and predicting defoliation. Using Liebhold's model, Figure 3 shows how this information can be used to correlate the predicted defoliation of an area. Accordingly, the estimated egg mass density of 846 egg masses per acre (average egg mass density in the proposed treatment blocks at JJRTC) x 29 mm (average egg length) translates to a projected defoliation level of about 33 percent (moderate defoliation). Because egg mass densities and host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately light to moderate throughout these areas of JJRTC. Light to moderate defoliation (29 - 33%) is projected at GSFC, NPMC and the NPGBL.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy throughout most areas surveyed. The overall average egg mass length is 30 mm. Egg masses larger than 25 mm typically indicate healthy populations with no obvious sign of stress from either the gypsy moth nucleopolyhedrosis virus (NPV) or the *Entomophaga maimaiga* fungus, two of the primary natural control agents that often express themselves in declining or stressed populations. There was no evidence that either one of these entomopathogens had significant impacts at these sites in 2002. Although it is still possible that either the gypsy moth fungus or the NPV could cause a general collapse next year, it is not likely to occur prior to a significant defoliation event occurring in 2003.

Predicting the extent of tree mortality that would result after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light-moderate defoliation (< 60 percent) are not likely to refoliate and there is probably no significant impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. A severe drought was experienced in this portion of Maryland during the summer months in 2002. Only small areas of light defoliation have been detected at these four sites over the last several years.

The Allegheny National Forest (1988) and the West Virginia Division of Forestry (1997) and the Cuyahoga Valley National Park (2002) provide examples of potential tree mortality. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28) percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak sawtimber and 14 percent of the total oak poletimber occurred after one year of moderate to heavy defoliation. At Cuyahoga Valley National Park following one year of heavy defoliation, significant mortality occurred in approximately 25 percent of the defoliated areas. In the mortality areas, oak mortality ranged from 22-98 percent and averaged 54 percent. In these examples, droughty conditions likely contributed to the level of mortality.

Based on observations of the existing health of the forested areas at these four sites and the factors mentioned above, significant tree mortality is not expected since only light to moderate defoliation is predicted. However, should droughty conditions prevail in 2003, individual or small groups of trees may experience mortality.

Management Options

For 2003, two management options have been evaluated for managing gypsy moth populations at these four sites. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage and overall health of the forested areas; and 2) reduce gypsy moth population below the treatment threshold. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga*. In areas with defoliating levels of gypsy moth populations (greater than 750 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels

Although it is not possible to accurately assess such events with information at hand, it is unlikely that a collapse will occur prior to defoliation since most of these areas are newly infested and there is an abundance of large healthy egg masses.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al. (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that noticeable defoliation will occur at GSFC, JJRTC, NPMC and NPGBL. Gypsy moth may also spread and infest other areas at or near these sites.

Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk).* This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis, which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al. (1996) in West Virginia. Miller's study involved a large-scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1-year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½-1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (3-5 days) as well as other biological

factors such as feeding activity and weather conditions, it has been difficult to project treatment efficacy. Most often foliage protection is achieved but significant reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 2×10^{11} occlusion bodies (OB's) per acre applied in two applications, or a single application at 4×10^{11} OB's. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. There are, however, sufficient quantities of Gypchek currently available for 2003 should this insecticide be preferred for use at these four sites.

Alternatives

With the previously described options in mind, the following alternatives are offered.

Alternative 1	- No action
Alternative 2	- One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre.
Alternative 3	- Two aerial application of *Btk*, as in alternative 2, applied 4-7 days apart.
Alternative 4	- One aerial application of Gypchek at the rate of 4×10^{11} OB's in a total mix of 1 gallon per acre.
Alternative 5	- Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations are healthy, building and sufficient to cause light to moderate defoliation on 92 acres at JJRTC, and 60 acres at NPGBL, 72 acres at NPMC and 42 acres at GSFC (Figure 2). To protect host tree foliage and prevent possible tree mortality, our recommendation is Alternative 4 (a single application of Gypchek). This recommendation is based on the following conditions:

1. Two adjacent federal sites, Patuxent Wildlife Research Center and Beltsville Agricultural Research Center, are planning to treat a total of 4,325 acres in 2003 with a single application of Gypchek (some of the treatment areas are shown in Figure 2). It is also planned to include JJRTC, NPMC, NPGBL and GSFC with these two sites in a single suppression contract. Logistically it would be much easier and simpler to use only one insecticide for the contract. Since these two sites will be using Gypchek, it is also recommended at JJRTC, NPMC, NPGBL and GSFC.

2. At the gypsy moth population densities encountered at these four sites, a single application of Gypchek will likely provide adequate foliage protection and reduce the existing population below the treatment threshold in most, if not all, of the treatment area.

3. The cost of a single application of Gypchek is about one half that of a double application of Gypchek.

4. Gypchek is host specific which minimizes the risk to other non-target organisms including lepidoperan caterpillars.

Only small and scattered areas of defoliation, if any, are expected elsewhere at these four sites in 2003.

REFERENCES

Allegheny National Forest, Warren, PA. 1988. Gypsy moth caused oak mortality – Allegheny National Forest, 1988. USDA Forest Service internal report prepared by Forest Pest Management staff, Morgantown, WV. Unp.

Cuyahoga Valley National Park, Brecksville, OH. 2002. Oak Mortality Evaluation. Cuyahoga Valley National Park, 2001. USDA Forest Service Internal report prepared by Forest Health Protection staff, Morgantown, WV. Unp.

Liebhold, A.M., Simons, E.E., Sior, A., and Unger, J.D. 1993. Forecasting defoliation caused by the gypsy moth from field measurements. Environ. Entomol. 22(1): 26-32.

Miller, J.C. 1990. Field assessment of the effects of a microbial pest control agent on non-target Lepidoptera. American Entomologist 36:2, 135-139.

Moore, K.E.B. and Jones, C.G. 1987. Field estimation of fecundity of gypsy moth (Lepidoptera:Lymnatriidae). Environ. Entomol. 16: 165-167

Sample, B.E., Butler, L., Zivkovich, C., Whitmore, R.C., and Reardon, R.C. 1996. Effects of *Bacillus thuringiensis* Berliner var. *Kurstaki* and defoliation by gypsy moth [*Lymantria dispar* (L.) (Lepidoptera:Lymnatriidae)] on native arthropods in West Virginia. The Canadian Entomologist 128:573-592.

West Virginia Division of Forestry. 1997. *In* 1997 Cooperative State-County-Landowner Gypsy Moth Suppression Program in West Virginia. 3p. (Brochure).

Table 1. Results of the gypsy moth egg mass survey at James J. Rowley Training Center, October 7, 2002.

Plot Number	Number EM/Acre	Plot Number	Number EM/Acre
1*	1,080	8	80
2*	560	9	80
3*	160	10	400
4*	80	11	0
5*	1,760	12	120
6*	1,440	13*	840
7	40		

Overall egg mass/acre range = 0-1,760
Overall egg mass/acre average = 511

Egg mass size range (mm) = 12-42
Egg mass size average (mm) = 29

* = Located within proposed treatment areas

Egg mass/acre range in proposed treatment areas = 80-1,760
Egg mass/acre average in proposed treatment areas = 846

Table 2. Results of the gypsy moth egg mass survey at the National Plant Germplasm and Biotechnology Laboratory, November 6, 2002.

Plot Number	Number EM/Acre
14*	520
15*	1,040

Overall egg mass/acre range = 520-1,040
Overall egg mass/acre average = 780

Egg mass size range (mm) = 18-30
Egg mass size average (mm) = 25

* = Located within proposed treatment area

Egg mass/acre range in proposed treatment area = 520-1,040
Egg mass/acre average in proposed treatment area = 780

Table 3. Results of the gypsy moth egg mass survey at the National Plant Materials Center, October 2, 2002.

Plot Number	Number EM/Acre
16*	600
17*	320
18	160

Overall egg mass/acre range = 160-600
Overall egg mass/acre average = 360

Egg mass size range (mm) = 28-42
Egg mass size average (mm) = 35

* = Located within proposed treatment area

Egg mass/acre range in proposed treatment area = 320-600
Egg mass/acre average in proposed treatment area = 460

Table 4. Results of the gypsy moth egg mass survey at Goddard Space Flight Center November 6, 2002.

Plot Number	Number EM/Acre	Plot Number	Number EM/Acre
19	40	26	200
20	80	27	40
21*	960	28	120
22*	1,400	29	0
23*	720	30	0
24*	80	31	0
25	0	32	0

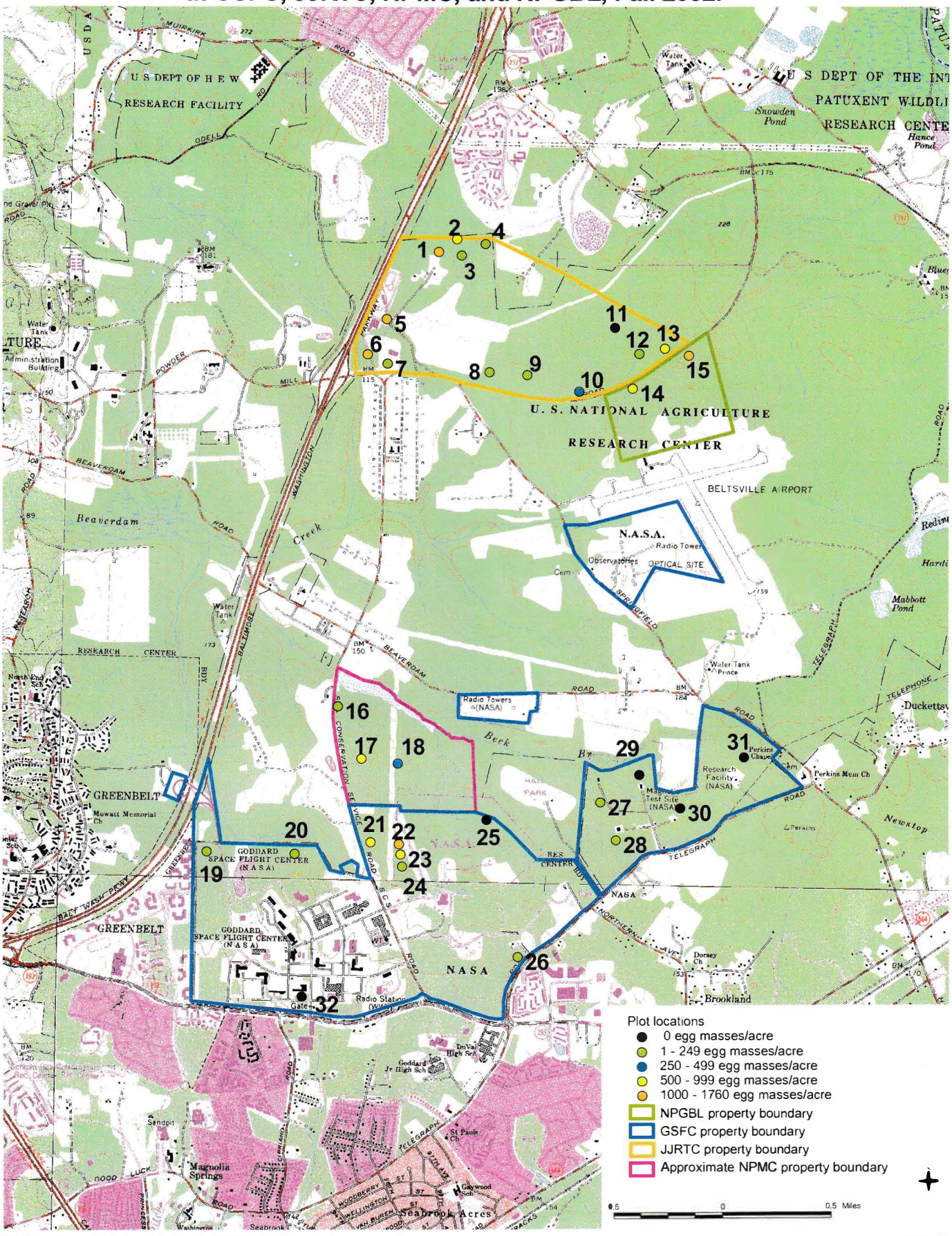
Overall egg mass/acre range = 0-1,400
Overall egg mass/acre average = 260

Egg mass size range (mm) = 22-38
Egg mass size average (mm) = 31

* = Located within proposed treatment area

Egg mass/acre range in proposed treatment area = 80-1,400
Egg mass/acre average in proposed treatment area = 790

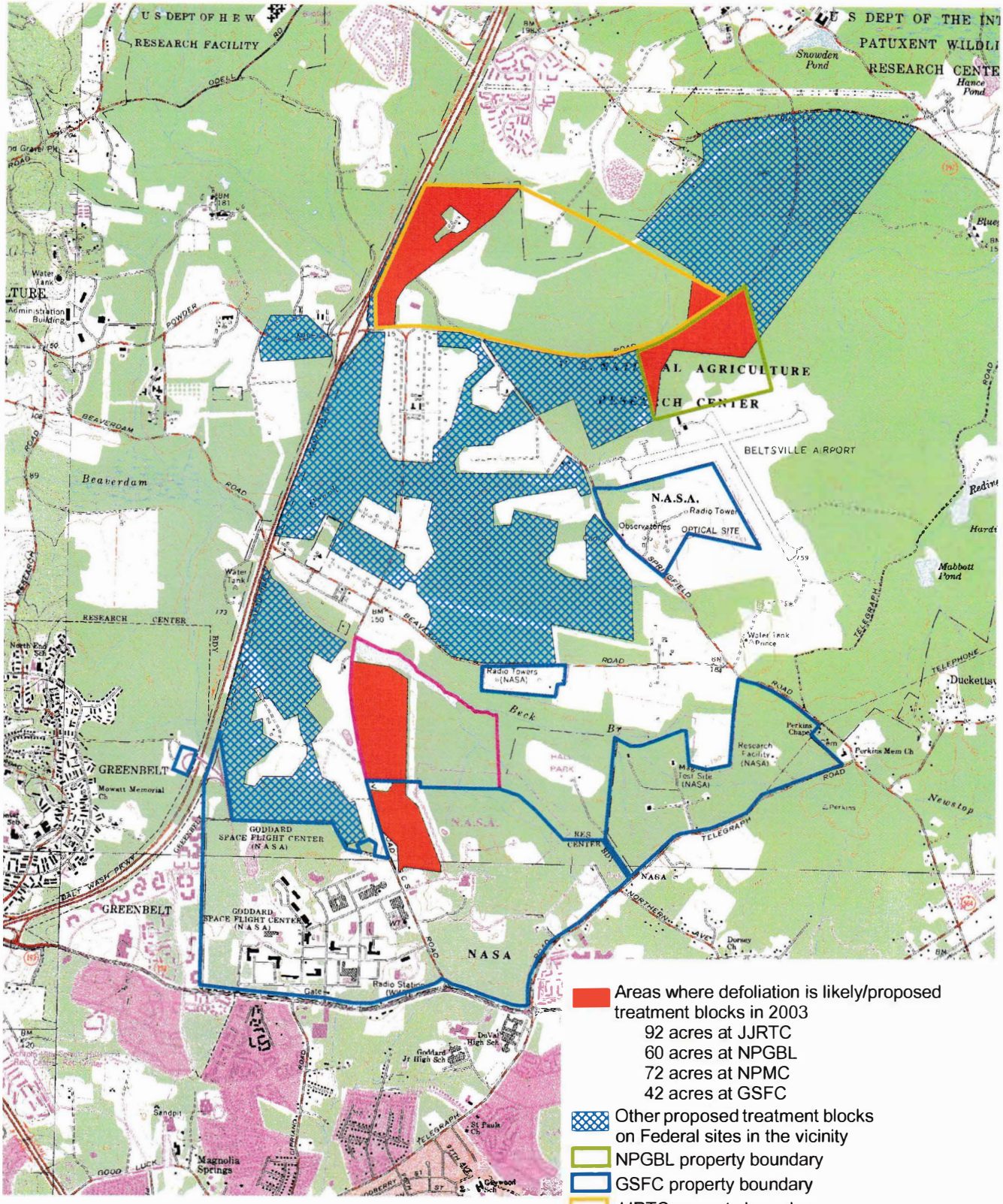
Figure 1.--Gypsy moth egg mass survey plot locations at GSFC, JJRTC, NPMC, and NPGBL, Fall 2002.



USDA Forest Service, FHP, S&PF, NA, Morgantown, WV

12/02 KDF

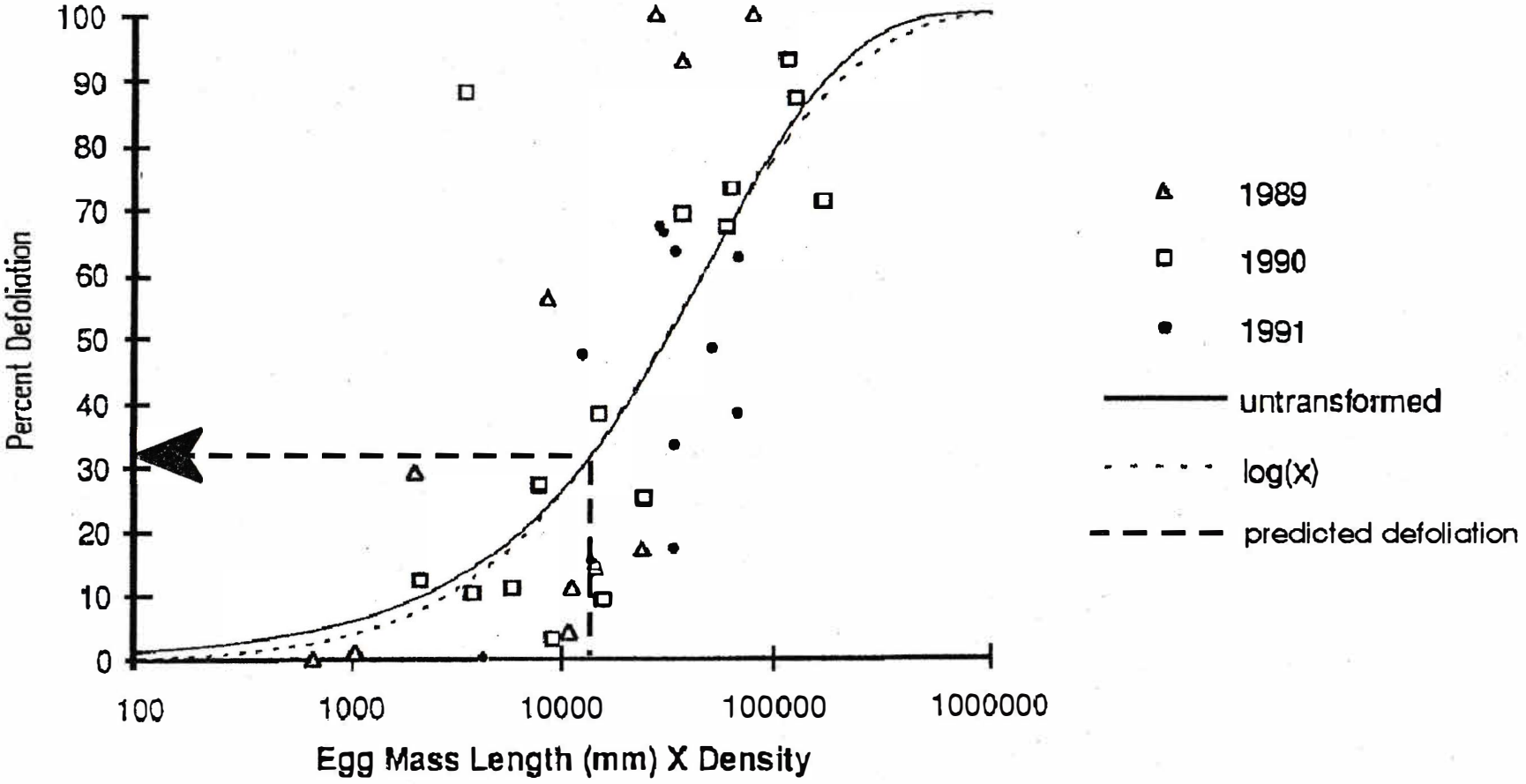
Figure 2.--Areas where gypsy moth defoliation is likely/proposed treatment blocks at JJRTC, NPMC, NPGBL, and GSFC in 2003.



USDA Forest Service, FHP, S&PF, NA, Morgantown, WV

12/02 KDF

Figure 3.--Predicted defoliation in the proposed treatment blocks at James J. Rowley Training Center in 2003.



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3400
Date: January 21, 2003

Wayne P. Claus plant
National Germplasm and Biotechnology Laboratory
APHIS PPQ NPGBL BARC EAST, Bld. 580
Beltsville, MD 20705

Dear Mr. Claus:

Enclosed is the gypsy moth biological evaluation for the National Plant Germplasm and Biotechnology Laboratory (NPGBL). Current gypsy moth populations are sufficient to cause noticeable defoliation on 60 acres. We are recommending a single application of Gypchek for this area. With proper application, gypsy moth defoliation should be minimal at NPGBL in 2003.

Please Contact Rod (304-285-1555) or Brad (304-285-1546) if you have any questions concerning this gypsy moth biological evaluation.

Sincerely,

JOHN W. HAZEL
Field Representative
Morgantown Field Office

Enclosure

cc: Robert Tichenor, MDA
Sally Hughes, MDA
Noel Schneeberger, AO

JWH/RLW/blm

United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3400
Date: January 21, 2003

Wayne P. Claus
National Germplasm and Biotechnology Laboratory
APHIS PPQ NPGBL BARC EAST, Bld. 580
Beltsville, MD 20705

Dear Mr. Claus:

Enclosed is the gypsy moth biological evaluation for the National Plant Germplasm and Biotechnology Laboratory (NPGBL). Current gypsy moth populations are sufficient to cause noticeable defoliation on 60 acres. We are recommending a single application of Gypchek for this area. With proper application, gypsy moth defoliation should be minimal at NPGBL in 2003.

Please Contact Rod (304-285-1555) or Brad (304-285-1546) if you have any questions concerning this gypsy moth biological evaluation.

Sincerely,

JOHN W. HAZEL
Field Representative
Morgantown Field Office

Enclosure

cc: Robert Tichenor, MDA
Sally Hughes, MDA
Noel Schneeberger, AO

JWH/RLW/blm

United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3400
Date: January 21, 2003

Darlene Squibb
Code 208.2
Goddard Space Flight Center
Greenbelt, MD 20771

Dear Ms. Squibb:

Enclosed is the gypsy moth biological evaluation for Goddard Space Flight Center (GSFC). Current gypsy moth populations are sufficient to cause noticeable defoliation on 42 acres. We are recommending a single application of Gypchek for this area. With proper application, gypsy moth defoliation should be minimal at GSFC in 2003.

Please Contact Rod (304-285-1555) or Brad (304-285-1546) if you have any questions concerning this gypsy moth biological evaluation.

Sincerely,

JOHN W. HAZEL
Field Representative
Morgantown Field Office

Enclosure

cc: Robert Tichenor, MDA
Sally Hughes, MDA
Noel Schneeberger, AO

JWH/RLW/blm

United States Department of Agriculture | Forest Service | Northeastern Area State and Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3400
Date: January 21, 2003

United States Secret Service
James J. Rowley Training Center
Attn: Charles Calarusso, Facility Manager Specialist
9200 Powder Mill Road
Laurel, MD 20708

Dear Mr. Colarusso:

Enclosed is the gypsy moth biological evaluation for James J. Rowley Training Center (JJRTC). Current gypsy moth populations are sufficient to cause noticeable defoliation on 92 acres. We are recommending a single application of Gypchek for these areas. With proper application, gypsy moth defoliation should be minimal at JJRTC in 2003.

Please Contact Rod (304-285-1555) or Brad (304-285-1546) if you have any questions concerning this gypsy moth biological evaluation.

Sincerely,

JOHN W. HAZEL
Field Representative
Morgantown Field Office

Enclosure

cc: Robert Tichenor, MDA
Sally Hughes, MDA
Noel Schneeberger, AO

JWH/RLW/blm

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